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ORAL HISTORY TRANSCRIPT

BURTON G. COUR-PALAIS
INTERVIEWED BY JENNIFER ROSS-NAZZAL
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ROSS-NAZZAL: Today is March 1st, 2004. This oral history with Burton Cour-Palais is being conducted for the Johnson Space Center Oral History Project, in Canyon Lake, Texas. Jennifer Ross-Nazzal is the interviewer, and she is assisted by Sandra Johnson and Rebecca Wright.

Thank you so much for inviting us to your home today. We really appreciate it.

COUR-PALAIS: You're welcome.

ROSS-NAZZAL: We're looking forward to talking with you. I'd like to begin the session today by talking with you about your experiences with Avro [A. V. Roe Aircraft, Ltd.]. Can you talk to us a little bit about your work there?

COUR-PALAIS: Yes. I originally worked in England for ten years on an aircraft project. I'm an aircraft design engineer, aeronautical engineer. When the chance came to go to Canada in 1957, we emigrated there, ostensibly to work on the new plane called the Avro Arrow, which there's a picture over there [gestures]. This plane was the most advanced fighter that either the U.S. or Britain had developed at that time, and it required some people that they did not have in Canada, so they went around the world, and particularly to England, to recruit people, and I was one of them.

We arrived there in May or so of 1957, and I went to work on a portion of that plane. That's the way it was done in the aeronautical field, where you only get a part of a wing or a part of a fuselage to design. So I worked on that. The Avro Arrow was a Mach 3 fighter at that time, extremely, shall we say, advanced, and it was part of my job then to bring my expertise from what I had in England to this thing.

After a while, the Canadian government changed. They had an election, and the new party that came in decided they did not want this plane anymore, so they canceled the whole project and went so far as destroying all the planes, so I don't think they have any left.

So one day we were all working there in our office, and we were told to go home, and that's it. So we were all fired. We'd been in Canada for two and a half years at that time. My Section Chief at that time, Mr. Bob [Robert E.] Vale, he was apparently taken with me, for some reason, and we had a small splinter group formed from the people who had been fired, and I was taken on for a little while, doing odd jobs, gave us time to breathe. Rowland, my son, was in school at that time over there.

Then we found out that people were start[ing] to come looking to hire this rather large pool of very expert people. They ranged from the very senior designers of that plane. They'd been in contact with NASA, particularly, and so NASA came a-calling. They were just starting up the Space Task Group in 1960 or thereabouts. I was fortunate enough that Mr. Vale, my Section Chief, was one of those who was instantly selected by NASA as one of those that they wanted on the project. He really was a brilliant man. He was a Canadian.

Along came my old company, the company that I'd left in England. They, too, came to try and get some of their people back. So my wife and I were left with this question. Actually, I hadn't been offered a job by NASA at the time. But anyway, through Mr. Vale and some of the other Canadians that had gone down to NASA, I was offered a job to join NASA. In every case, because we were British citizens, those who were British citizens and the Canadians were asked to become American citizens as soon as they could, which was a five-year process. I agreed to that.

So once I had an offer of a job from NASA and an option of also getting my old job back in England, from the company that I'd left, well, I had this dilemma, wondering which would be best, and I suddenly decided that I had taken the bold step of leaving that company to go in search of something new; I'd better carry on, follow my nose and do the next most exciting thing, which was space.

So in January of 1960, I joined Space Task Group. I went down there on my own and left my wife and son behind in Canada for a little while till we found someplace to live. I immediately got involved with the Space Task Group. At that time, Mr. Vale, Robert Vale, had already started up a portion of the Mercury Engineering Group over there, and I was assigned to his group and worked on Mercury. I think the question is asked over here, was my former line of work relevant. It was highly relevant because both of them are what we call aircraft structural type of design systems, and the portion that they gave me specifically to work on was the part that joins the escape tower to the capsule. There was a clamp[*] that required to be really strong enough for [lift]off, but then if they had to use the escape tower, it should be strong enough to lift the Mercury off the space vehicle, and also it had to be discarded at the appropriate time. So I worked on that [in Mr. Vale's group that included many] Americans. By that time we had quite a big group there in Space Task Group at Langley [Research Center, Hampton, Virginia].

[*] This clamp was a metallic ring that joined the escape tower to the rest of the Mercury spacecraft.

Then along about the time when they decided that they wanted to do Apollo, I got involved with that. The same group was then put on the design team for Apollo. There were two lines of approach to the Apollo capsule; one was the one in which I was most familiar with, which is based on aircraft design, which is what they call frames, skin, and stringer, where you have a frame and you have these long pieces of aluminum that make the shell and put aluminum on the outside. That was one design that was being considered, and I was on that line. Then my colleague was on another design, which was what we called the honeycomb design, which was the one in which you have aluminum honeycomb with two face sheets of aluminum [on] either side. That makes a very rigid structure as well. So both of these were being considered at the same time, so that the designers could check their relative merit, weight, and all that kind of stuff.

While I was busy on that, and because we were going out into space for the first time, they began to worry about space hazards outside the atmosphere. Apart from radiation, which everybody knew about, they knew very little about the meteoroid population. That was definitely going to be an unknown.

One of my other colleagues in that group was given the task of looking into the meteoroid problem, what the magnitude was, and how we could best protect against that, and what would be the probability of us getting through it. He, to my great surprise and, I guess, ultimate joy, didn’t want the job, so he asked me if I would like the job. It’s just serendipitous, I guess, that I said yes, and I started from scratch at that point, knowing nothing about meteoroids, nothing about protection, but going into the whole process of learning about it and following up the leads.

The first thing I had to do was to find out about meteoroids in general, and I found that the center of all of this stuff was in Cambridge, Massachusetts. The Smithsonian Astrophysical Observatory had been doing this work for thirty years. What they were doing was taking pictures of meteors* as they enter the Earth's atmosphere, recording them, and getting all the information they could about what times of the year they appeared and how brilliant they were, but they used the term *magnitude*, which compared the brilliance of a meteor [with a reference star]. Have you all ever seen a meteor?

ROSS-NAZZAL: I think maybe once or twice.

COUR-PALAIS: Well, you can compare that against a known standard star [as] they [did], and they [gave] it what they call a magnitude number. Well, we designers couldn't do anything with a magnitude number. What we wanted to know was the number of meteoroids and how heavy they were, what was their mass, what was their speed, and what was their mass density; that is, how solid were they. And they had none of that kind of data, so I spent a long time working with those guys up there, pushing them on the envelope to do things that they'd never done before.

Dr. Fred [L.] Whipple, who was a very well known astronomer, a physicist, he had been in this game for a long, long time. They eventually started to assign what we call mass levels to these magnitude numbers, so that they could then allow us to know how heavy these particles were. They already [knew] how fast they went.

So in time, working with them, pouring some money into them to have new ways of measuring. What they'd been using over the thirty years was optical telescope [systems]. They

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* A "meteor" is the trail, visual or radar-sensitive, caused by a "meteoroid" or "meteorite."

had one [such system] in New Mexico [and another] one in Harvard [Massachusetts], and they'd get pictures of [meteors] on these huge cameras. With the onset of radar, we pushed them into [this] area, where they could pick up the whistle of meteors as they come through the atmosphere, and this allowed them to extend their knowledge beyond what they had before and into a realm, which was of more importance to us for Apollo.

The Apollo mission was going to be three and a half days to the Moon, a couple of days on the surface, three and a half days back, so not really a long time outside the Earth's atmosphere, so we were always working on the probability of impact, and we needed to know [what the probability was], and we ended up finally with that being the baseline for our work.

You mention this a little later on here, but it all comes in the same context. At the same time NASA was sending up satellites to measure the even smaller ones, so eventually we got a graph, what we called a flux mass [plot], of meteoroids, their number per unit area per unit time, which is what we needed, and their size. So we eventually were able to put together what we call a mass flux curve for the [meteoroids], and we had to be able to describe how dense they were.

Now, most meteors, from just observation, if you've ever looked during a meteor storm, they break up very high in the Earth's atmosphere, which told everybody that they're very, very fragile. They really are pieces of ice. But occasionally there are some of them which are more dense than that, that can come through and hit the Earth. So across the lake over here is a peninsula [gestures]; you can see it. Before the Apollo, we used to go out there [with] our observation truck, and my group and myself would sit out there all night, recording meteors and looking at the number density and also looking at—we had a camera which would tell us how dense these things were. So, putting this all together, we had eventually put together our knowledge of what we were facing once we left the Earth's atmosphere.

The next thing to do was to try and find out how we could protect against this stuff, having known what the problem was, we had to then come up with the solution. Here again, I had to start from scratch. The Ames Research Center in [Moffett Field] California was the leader in what was called hypervelocity impact research. They had a gun, specialized gun, that could fire very fast. Now I'll throw some numbers at you. These [meteoroids] could hit our spacecraft at anything between eleven and twenty kilometers per second. The guns that they developed could only fire up to about eight. So we were never able to fully, even with the very best one we had at that time, able to get the speed of the test device to equal the speed of the object.

So this is where a lot of physics came into the game, and it's where my expertise came in, too, and the group that I worked with. We had to do our research at the best speed we could, and then extrapolate into the meteoroid business. But I'm getting ahead of myself. The guns that I saw at Ames were very impressive. We at NASA Johnson—at that time Manned Spacecraft Center—did not have such a gun.

One of the questions you asked over here I skipped over—an important social question. In other words, what about coming to Houston, and did anybody come and show us what it was like. I know they had many people come to Langley to tell us about how wonderful this area was and all the rest of it, but we did our own research, my wife and myself and Rowland here. We drove down and found ourselves a little home in La Porte, Texas, in a place called Bay Colony, and we lived there for several years. But that's something you can add in later, since you did ask the question. Nobody pressured us into doing that, but the Chamber of Commerce did come to tell us how wonderful the place was. But we were coming here inevitably anyway. [Laughs]

Our first office was in the Rich Building on Telephone Road, an old warehouse, and there was no place for a gun over there, but I continued my visits to Ames, and by that time there was another defense contractor, General Motors Defense Research Lab, in Santa Barbara, California, that was also doing the same thing. They sent a representative out to see us, and I got to go and see their gun, which was even more exciting than the one at Ames.

I was in a branch that was studying spacecraft design under [Joseph N.] Kotanchik in the Rich Building, and I persuaded my Section Chief [Leslie St. Leger] and my Branch Chief [Bob Vale] that we needed such a device if we were going to keep up with what the contractors were going to do. I was able to talk General Motors [in]to sell[ing] us a copy of their gun, the exact one, and with the diagnostic equipment, and come and train us how to use it.

Around about that time, we moved to Ellington Air Force Base [in Houston, Texas and], in a remote part of the field in one of the old barracks buildings we set up this gun, and I hired one lead engineer [Tom Lee] who I had done some work with at the Utah Research and Development Corporation. [Tom] took over the gun and trained some of the local contractors, under the supervision of the General Motors people, to learn to operate this thing. So we had an operating gun while we were still at Ellington, sometime between 196[2] or ’6[3] and whenever the new space Center was built. So we had that gun there for many years and did a lot of our early research work there.

Amongst the things at the time we were researching was basically with the knowledge we now had of the meteoroid, is to try and duplicate what we thought the meteoroid would look like, little glass beads, and fire them as fast as we could, which was about 7 kilometers a second, and just start building up the basic research that we, NASA at Johnson, did not have, but relying very much on the stuff that they had from the West Coast.

So that was my main goal at that time, having worked and got the environmental side of it done. Not only me, but the other NASA Centers. We had a chart which we could use for the meteoroids [that] could calculate the probability of impact during the seven-day, ten-day journey, and decided what size was going to be the most lethal, and then decided to try and protect against it.

A question you also asked about Mercury, what did Mercury do for us. I was there for the first launch of Mercury because I was at Langley, and followed the whole program through, and I think the very last Mercury we started to examine in the Mercury [Program], in our ignorance for pits when we recovered them, for impact pits. The design of the Mercury outside shielding was corrugated and was very difficult to find anything, but we found something from our impact research and also from looking at glass windows [that they] made the perfect detector. You could see an impact on a window because if you’ve seen somebody who’s kicked up a stone chip against your car, you can see a tiny little thing would make it big. Well, this happens the same way with meteoroids at high speed.

So we were able to then decide from now on we’d only scan the windows. The first one we ever found an impact on was Mercury-[Atlas] 7. I don’t know if it was [M. Scott] Carpenter or who it was, but anyway, that provided a lot of excitement to us, because it was totally unpredictable, it was outside the realm of probability for that short mission, and yet when it was scanned electronically, it showed very interesting iron deposit. So it’s one of those sneaky ones that was not a cometary particle; it had come maybe from the Mars zone, a stony or metallic type of meteoroid. Outside the realm of probability, it hit that window. But that became a showstopper for many years to come. It would be trotted out and shown to many people. But we used that.

Later on when we put that on our curves and looked at it, it was an anomalous event; it wasn't what we would really expect. But it led us to do the same for Gemini, so whenever Gemini started flying, that was the rule of the day. We always examined the windows, and as the missions got longer and longer, it became more possible, and we did detect meteoroid impacts on Gemini windows, which later on became part of our flux curve, and yielded some important research for some other people.

The first Gemini in which they opened the hatches and the crew sat out there in the open, we felt sure we'd see some impacts on their suits, and later on when they did do EVA, that's the other thing we started doing, was to examine their suits for traces of little black dots and things like that. I should say we didn't see anything that was very conclusive on that, because the actual time they were out, and all the shielding from the spacecraft itself, the windows and things, the hatch and doors, prevented real impacts. But we were very cognizant of the fact that we had so many different tools to try and find out what we were against.

The particles we were talking about were very, very small, especially for spacesuits, but enough to puncture a spacesuit, to get into the outer layers. The outer layers of a spacesuit are designed to protect them against heat and radiation, and then as the meteoroid people, we used that thickness to allow us to see what it would do, but nobody wanted them to puncture the pressurized rubber bladder suit that they wore inside. So that was our very earliest research on that.

The very earliest spacesuits were very thick, and the first one we had to deal with was when I was at Ellington, we didn't have an appropriate gun, but we did have a 12-gauge shotgun, so we shot at that, just to see how this kind of material would react. Later on, we replaced the shotgun with what we called a low-velocity gun; it could fire small particles, [and] was also at Ellington.

But that spacesuit was so immobile, the astronauts would not be able to bend. Too thick. So this led us into another area which eventually I would have to deal with, would be spacesuit design. Spacesuit design belonged to the spacesuit engineers, but from the meteoroid aspect, what protection could we get from it.

So we were at Ellington, and eventually around about that time the Apollo was getting geared up, and they appointed me the Subsystem Manager for Meteoroid Protection, which is not in your list over here. That actually allowed me to work directly with the Apollo Program Office, and yet be a member of the Engineering Division, the Meteoroid Space Physics Group, the Meteoroid Technology and Optics Branch, it was called.

But I had the option then to work with North American Rockwell [Corporation], who were my counterparts, and through my representative on the Apollo Program office, Dick Collona, and that started, I guess, my real work in hypervelocity impact theory. We did a lot of research work, and I actually found something which was a very important advance in the application of this work, which was that even though we couldn't fire at 8 kilometers a second with the kind of projectiles we were using, there was a gun at North American which worked on an entirely different principle, [plasma-physics] principle, in which they fired very, very small [projectiles]—the kind of glass beads you see [on] reflectors on the ground, you know, tiny little things.

But people were skeptical about the results from that, because it was hard to really define what was happening, but I found that I could take their results and combine them with the results that we were getting and come up with a definite correlation that would allow us then to use this man's work, Scully's work at North American, which allowed us to move our entire projections up to 15 kilometers a second, which really doubled the amount of the verification that our extrapolations could be correct. So that was an important thing that happened during that time.

I continued to do most of my work—the stuff that was being done on the meteoroid work after I'd got what I needed was more as redefining some of the smaller portions of it. You mention *Pegasus* over here. I knew about *Pegasus* and followed the results and used their data points to see how well it fit on the curve. We did a few tweaks on the curve that we needed. But primarily the emphasis shifted to how to protect all aspects of the spacecraft.

Now, when it came to probability, the engineers decided that the probability of mission success, or probability of crew survival, would not include meteoroids, that they would exclude that, but they'd have all the engineering stuff they needed—the launch troubles and whatever else they had, and we were supposed to be a separate entity. So they gave us a number to shoot for, which was, I believe, one chance in a hundred of an impact that would cause the mission to be unsuccessful, which could mean many things. It could mean either that a meteoroid could go into the huge thruster bell at the back. If it made a big enough hole in there, the heat from the engines when they started it up could make a hole in that, and from that the whole thing would fall apart, or it could damage the radiator panels, or it could damage the windows to the point where on reentry the thermal stresses of reentry would cause the windows to crack. In some senses it could go through the thermal protection around the command module.

So each one of these things had a very different penetration equation, as we call it, penetration mechanics problem. So, during the course of my time as Apollo Subsystem Manager for Meteoroid Protection, we fired at and came up with the ways to protect all of these different things, because the windows, the spacecraft command module, thermal shielding, the service module, which was a very special case—I'll talk about that—and the engine bell.

And then later on where we had to do the same thing for the lunar lander, the lunar lander was built very, very differently from Apollo, but it, too, had to withstand a different kind of environment which, when it landed on the Moon, there the environment was dust. We knew from *Rangers* and *Surveyors* and things like that, that dust was constantly floating around, and that was what we call a low-velocity impact at 2 kilometers a second. And the strange thing about this is that once you've designed something for a hypervelocity penetration, it's useless against low-velocity penetration, so we had other things to deal with.

I don't know if you all have seen pictures of the LM [Lunar Module]. You've all seen it have you? It had big bug eyes, you know. Originally they were made from ordinary tempered glass, and the first thing we found out when we fired at tempered glass is that it just shatters like any car glass will shatter into little nuggets. So this was obviously wrong, so we couldn't do that. So we were able to put a stop to that. So they had to redesign the windows and come up with a different kind of glass which would not shatter into little nuggets when hit by lunar dust. So that was another contribution we made to that.

But [we] generally spent [the] years before the landing developing penetration equations and just tweaking our results and finding out new ways of doing things to assure that they got the reliability that they wanted for mission success. The reliability they gave us for total mission failure, we would never reach that.

Anyway, so we did come up with a number for the mission success which allowed them to come back if anything happened. The big problem behind the service module, which was made out of this honeycomb, were the big oxygen and hydrogen tanks inside there. We couldn't stop anything coming through without touching those tanks. By testing tanks, which were under pressure, we found that we could allow a slight ding on the outside of the tank wall which wouldn't cause it to fail. So that was the criterion, but we never reached that. But that was the fallback position we had.

I retained that position for several years, and then after we moved to Building 31 on the main campus, they had built for us a special lab, gun lab. It had a roof that would allow [venting], in case of an explosion—this gun, incidentally, was a hydrogen gun, so it was very possible to have an explosion. But the roofs were designed—they had huge fans on the roof. The whole thing was designed for a gun lab. In that gun lab we had a Lockheed [Aircraft Corporation] team—I think it was Lockheed by that time—that would run the gun, and a NASA supervisor.

It was during that time that they made me the Chief of what was called the Meteoroid Sciences Branch. I think the timing would be somewhere between maybe '67 to 70, something like that. During that time, we did a lot more research in that gun lab over there. We also came up with other ways of trying to get the speed higher. I mentioned earlier, the big thing was to try and get the speed.

But while I was Chief of that branch, we had many contracts to try and improve guns. One was with McDonnell Douglas [Corporation] on the West Coast. They had a man there who had designed a new form of—one of the internal components of the gun was a piston, which would improve the velocity quite considerably. So I funded that. Funded one at [Texas] A&M [University, College Station, Texas], where they had another kind of device which would try [to] increase the speed of a regular gun. Then funded what was called a shaped charge gun, an explosive gun, again. I had two of those projects going, and one of them was very successful, and it was around about the time when the Apollo landed, that we got that.

Anyway, the Apollo landings went all right. Nobody got hurt. Apollo 13, when it blew up, I had gone to the launch, we had all gone to the launch, and I was on my way back when they told us that it had blown up. When I got home I found that the phone had been ringing, asking me if it could have been a meteoroid impact. So we did some numbers on that and concluded that it was not possible, not from a probability point of view. The only one I ever saw launched was the one that did come back, fortunately. But anyway, [I kept up with] the other lunar landings. On 12, I don't know who the astronauts were. I'm sure [Charles] Conrad [Jr.] and [Alan L.] Bean.

Earlier, we had launched the *Surveyor* probes to try and find out what the soil was like over there, and we left *Surveyor 3* in this crater for several years, and when Bean and Conrad, or whoever it was, they visited that *Surveyor 3* and they brought back the camera housing and they brought back a couple of lengths of tubing, which were very, very important to us to see what had happened in terms of the impacts on them.

When they brought them back, we were allowed to examine them in the Lunar Receiving Lab. We had all our clean room stuff on and all the rest of it, and we examined and came up with some results which were later published of what we found on them, not much from a meteoroid point of view and some impacts from definitely the effect of dust. It was very interesting that when the Apollo was landing in that crater, it blew up a whole plume of dust which marked *Surveyor 3* so we could see where bolt holes were and all the rest of it. It was a very interesting conclusion we came to, that dust was very easily blown around over there. It could get into anything.

Anyway, that *Surveyor 3* and the results from that led to the demise of my branch, because we were asked to give a report to Dr. [Anthony J.] Calio as to how well did our meteoroid environment stand up and what had we found, and we gave such a glowing report that everything had turned out so well, he said, "Good. We don't need you anymore," so he canceled the branch. Several of the fellows in the branch were able to find jobs in other parts of the Center, but they kept me on for several years as a Principal Scientist in the new Geology Branch that formed after that in, I think, the Space Physics Division. I don't know what they called it. You have some titles over here.

Let's see if there's something else I can say before—because it starts a whole new phase after that. Well, this window business became a real boon to us, because we were able to examine every Apollo window, those that had gone around from Apollo 8 through Apollo 17.

After the dissolution of the branch, I became the Principal Investigator for what was known as the Apollo Spacecraft Passive Meteoroid Experiment; S-176, it was called. So while I had some staff, we used to all examine it together, but after they left me on my own, I did all my own optical work on that. At least in three of the preliminary science reports, on Apollo 15, 16, and 17, I had reports on those, and then later on, was able to write some scientific papers on those. We followed the same procedure through into Skylab, the Apollos that were attached to Skylabs, because they were much longer duration and had a much better probability of getting impacts, and we did find them. This book that I hold in my hand here has pictures of them, too.

But later on, some colleagues of mine in the geology group took those same windows and they took them to the next level with a scanning electron microscope and they looked right inside the pits of them and they found the very first evidence of orbital debris, because each one of those craters was lined with aluminum. That was the beginning of the orbital debris side of the story, which ultimately has become more of a problem than the meteoroid problem for us out there in space.

So after the dissolution of the branch, it got even worse. They put me into another group temporarily, which was totally out of my field. But then I got picked up by the Environmental Effects Office. I think that's what they called it; I think you wrote it down here somewhere. Environmental Effects Office, yes. I was in there, as you say, between '74 and '78, and during that time they gave me what was known as the Troposphere Project. Here we were dealing with the effects of the Shuttle launch. In the troposphere, all the Shuttle gases and all the rest of that were affecting everything around it before it got into the stratosphere, where somebody else took over. But my job at that time was, again, to manage some of the programs that we looked at.

For instance, they were worried about the orange groves in Florida. The Shuttle plume, if it blew in a certain direction, would cover the orange fields and speckle them, and though it didn't damage the fruit, marketability was a real problem. The same thing happened with the bees and the honey. As the guy in the Shuttle Project Office said, "You guys are turning over every stone you can to look for some trouble."

But really, people would come to us and ask us what's the effect of the Shuttle gases, and it's always a question of predicting how that plume would work. You've seen pictures of it. When it takes off, it's got a beautiful plume. Which way will it drift? Models were derived by, as you have over here. I worked with Marshall [Spaceflight Center, Huntsville, Alabama], KSC [Kennedy Space Center, Florida], Langley. All of those people were involved, and we managed to get very good cooperation between all of us, and eventually clear the Shuttle from most of the environmental effects that they discovered. They even bothered about the manatees. You know, just the total effect on the people and the area of that cloud.

I learned an awful lot about acid rain. I learned an awful lot about something that's totally out of my field, environmental effects. I learned a whole new way of looking at that kind of stuff. It was an interesting three years, but then that office, too, disappeared. That's when I finally found a job with the Technical Planning Office.

In the meantime, while I was in the Environmental Affects Office—I'm sure you've interviewed him, Don [Donald J.] Kessler. Do you know that name?

ROSS-NAZZAL: I know the name. I don't think we've interviewed him.

COUR-PALAIS: Don Kessler was one of the guys in my branch, but he was just brilliant on his own right, and he was "Mr. Orbital Debris," and was able to come up with the whole project in its infancy before it really got to the point where it is now the biggest problem we have. He and I shared an office together. When the Environmental Effects Office was disbanded, they sent him away into some obscure corner in Flight Division or somewhere like that.

I got into the Technical Planning Office and I was the sole, shall we say, banner waver for orbital debris left around to attract any attention. Joe [Joseph] Loftus, my boss, I was able to get him interested in orbital debris. From that, we got to Dr. [Robert R.] Gilruth and got him interested in orbital debris, and got Don Kessler out of the dungeon, wherever he was, and he got into a position where he could get on with the work again. In that respect, I did contribute to getting it rolling again, and with him followed that.

The Technical Planning Office question as asked here, what did I do over there. One of the things was working with orbital debris over there. Another thing was working with Dennis [E.] Fielder and Joe Loftus on whatever projects they were coming up with, some of which was, it seems to me, to do with, I don't know, payloads things and stuff like that. Nothing that I call more interesting than orbital debris was.

But anyway, that, too—it didn't come to an end, but I was transferred out of there to whatever the next thing was. Solar System Exploration Division. Space Sciences Branch, under Drew [Andrew E.] Potter. Jeanne [Lee] Crews—you've probably already interviewed her—she was starting up the gun lab again in Building 31, but basically the geology group had taken over my old guns. They were in charge, but she had a little corner where we started with a little gun.

So she started work on that again, and when I joined her on that, we worked as a team together and gradually, under Drew Potter and that group, we managed to get our own building—I've forgotten what the number was, in the 200 Series or something, in the back forty over there somewhere, the gun lab and me. [We] immediately got the kind of gun that we had originally got from General Motors, plus another one, and started this experimental work all over again, but this time with orbital debris in mind, not meteoroids.

The orbital debris environment was being defined daily by Kessler, who had now joined the same group that I was in. He and several other people under Drew Potter, the Space Sciences Branch, were doing all the measurements now and forgetting what meteoroids were doing—orbital debris—so we were having to fire a different size of projectile, a different kind of projectile, aluminum projectile, and we were having to fire it at speeds which were more common to what orbital debris—orbital debris will strike a spacecraft going about ten kilometers a second, and we were nearly there. So we were able to do a lot more research again, and that's what I was doing this time.

Skylab. The question is asked here, did I have anything to do with Skylab, in the development of Skylab. I did. Skylab, we had the S-IVB tank was made into the lab portion of it. Again, it was a honeycomb design. Because of the long-duration mission, missions that compared to Apollo, it was subject to a much larger projectile, and we had to design an outer skin to cover that, which would stand off five inches from the basic module. This outer skin, the whole idea was it was collapsible, that on launch and takeoff, it was flush; it was wrapped around flush. The front end of the tank had a faring around it, which was supposed to keep the air stream, the dynamic air pressure as it was climbing, from getting under that skin and peeling it off. We went with that skin. It was not an easy sell. I had to ago to Marshall and appear before Wernher von Braun and tell him why we thought we needed this skin, that the basic shell would not meet the reliability, and since Johnson Space Center had the astronauts' safety—we could again call mission safety as a result—and he eventually agreed that we could do it.

But unfortunately, for some reason, during launch and during ascent, dynamic air pressure got in under the skin and tore it off, tore off both sides, all of that outer bumper, and in doing so, also tore off one wing, one of the solar panels. Well, that caused a great storm. I remember Gilruth saying, "Who was the idiot who designed this?" [Laughs] I don't know if I was around at that time anyway.

Anyway, it was a definite necessity to have that, and now with that gone, I was not involved with the fix. As you mentioned in here, the fix was they went out and put an umbrella sort of stuff over the spacecraft. But our job was to ensure that what was remaining of the protection would be adequate, and we were able to convince them that even though it was not as good as it was, it would be adequate. So we did have to do some number-crunching on that, do some more tests and stuff like that. So that was our involvement with Skylab.

But the other part of Skylab was the Skylab Apollos that were attached to the Apollo. As I already mentioned, the windows were now available for examination and we worked with that.

Space Station Project. I worked on several Space Stations over there for some reason. We seemed to be doing Space Station a long time at NASA. I think in Technical Planning Office I worked on Space Station a little bit. One of the big things that happened in our life together, Jeanne Crews and myself, in the branch over there, was we invented what is shown in that *National Geographic* magazine there, the multiple shield bumper, and we got this patent award, which is underneath that one. She and I have a patent then for the multiple bumper design, which was going to be used on the original McDonnell Douglas Space Station, Space Station Freedom. It's now being used in various forms for other missions and things like that. But that's a picture of me and Jeanne Crews there in *National Geographic*. Thought it was important enough to come and take that picture. So we did that.

In the meantime, I was a member of the Hypervelocity Impact Society and, over the years, presented many papers over there. Eventually they made me a distinguished scientist, in 1996. That's my award over there [gestures], Distinguished Scientist Award. That was a big highlight in my life, because when I first got into the game they told me that I would do all right, when I went to college, but I wouldn't—it was in England—they said I wouldn't set the Thames on fire. [Laughs] So when I got that thing, I couldn't help but resist, "Well, maybe I didn't set the Thames on fire, but at least I dropped a match in it."

So with Jeanne Crews, we got pretty well famous with that one, and it was so classified at the time that everywhere we went, we had to go to show it to the Defense Department, and several times we would have to arrive at someplace and then find the National Guard Armory, after we landed, to lock up the stuff. It didn't get declassified until maybe '94 or something like that, but it finally did get declassified and it's now available. We always went together to present it.

The other thing that happened to me, it was during the time when Star Wars was going on, Defensive Shield [Definition]. Here again, I was a NASA representative on this Star Wars* Defensive Shield development in which we were designing spacecraft up there that would shoot down other spacecraft. It was a consortium of many people, and we used to meet at Wright-Patterson Air Force Base [Ohio]—they were running the show—and we got people from the defense contractors. So I spent two or three years on that. That was an exciting part of the game, too.

Space Station Freedom. The question is asked here, why did I leave NASA. I don't know. Sometimes I wonder.

So I've mentioned what were the most influential discoveries, as far as I am concerned, in the areas of micrometeoroids, and if you want to go through some of these, we'll get them in a minute.

Space Station Freedom with McDonnell Douglas. Here again, it was a question of trying to—I worked with McDonnell Douglas while I was still at NASA, working with them while they were working on this thing. They'd come and give us their reports and we'd talk about shielding, basically, various aspects of shielding. I had many contacts with them.

In 1989, after twenty-nine and a half years of service, I got scared of what they were going to do to our retirement for some reason—Congress was fooling around with something—and I thought, "Well, might as well get out now while the going is good" sort of stuff, and I did, and McDonnell Douglas in Houston gave me a job. So I worked on the same thing, working opposite Jeanne Crews in NASA, in the gun lab in NASA, but as a McDonnell Douglas employee.

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* Star Wars was being developed between 1984 and 1988, under President Reagan's administration.

I worked on the development of that shield that I mentioned over there, and the use of it on the Space Station. It got to the point where we were doing design studies. The big thing with that one is, it's a little bit more complicated to install, but it gives you much better protection than what we had. They were going to use it on some of the external tankage, and it got to that point when another election occurred, and this time McDonnell Douglas was out and basically we got that new Space Station, the one that they have now, International Space Station, which the Russians came to join in, and I've had nothing to do with that since then.

But with McDonnell Douglas I basically continued the same kind of work that I was doing, extending the knowledge of impact studies and working with other contractors working with NASA. I did four and a half years over there, and then I finally retired. I came up here and I was a consultant for them through Southwest Research, and I'm still a consultant for Southwest Research Institute [San Antonio, Texas] over here. I have one final project to finish with them at the moment.

General post-NASA. Well, I think the most significant accomplishment in my career with the space program would be the development of that shield. It really was something that was so simple at the time, had missed it for all these years, as to why that should work like that, and it did. Eventually it sort of came to me one day when I was working with the Star Wars people. I saw something there that reminded me that that's the way it should go.

In the meantime, Jeanne Crews had been asked to look at a flexible material, not aluminum, Nextel. Nextel is a sort of ceramic cloth. She and I decided that we'd take a look at it and see what it was like, and we found it worked even better than aluminum. The trouble with aluminum is that when you impact it, you create little globules of aluminum that make a secondary environment and go and bang up other parts of the Space Station. With that thing, if that's on the outside, it doesn't do that; it's just little fibers of glass, like fiberglass. From what I can tell right now, they have various ways of using that on the current Space Station, too, and in other ways.

I keep in touch with NASA from time to time. Most recently, I did a paper on glass impacts with another consultant, which was presented at this latest Hypervelocity Impact Symposium. I presented my own paper when I came down to Houston. This is '04, right? They had one last year. Two thousand one, there was a conference in Galveston [Texas]. I presented my paper there. I've done many papers.

I don't know what would be the most challenging milestone. I think it was all a challenge to me. One reason why I continued to do that work, when my friend Jack Hall gave me the job way back on Apollo [at Langley], it just opened up a whole—my whole career has been based on that. I'm still doing that right now, that kind of work, and this latest paper I presented in November had to do with going back to look at what happens to glass when you impact it.

Well, you can ask me questions or, if I can't remember, you might jog my memory for something else.

ROSS-NAZZAL: Let me ask you just a couple of questions that I've thought of as you were talking. Earlier you mentioned that you worked with North American, you worked with Grumman [Aircraft Engineering Corporation], you did some work with Texas A&M, you did some work with GM [General Motors]. Can you give us a sense of what your workday was like, what your workweek was like during these programs, from Mercury, Gemini, and Apollo? It sounds like you were fairly busy.

COUR-PALAIS: Workweek?

ROSS-NAZZAL: Workweek or your travel schedules.

COUR-PALAIS: I guess the first time I ever traveled anywhere was from Space Task Group. That was my first time. But after that, it was a question of if I wanted to see something, I'd put in for travel. My workday would be like visiting the lab and looking at the results. In latter years, taking my work to a lab and letting them fire at it and looking at the results and bringing that back. The workday would be I guess eight to five.

Working with my opposite numbers at Rockwell during the Apollo era was very challenging, because they were not a dormant type of people at all and we had many small conflicts between us. They were the designers and I was NASA telling them not what to do, but by the same token, we had the responsibility to the Apollo [Program Office]—or I did at that time—to make sure it was correct. Therefore, I was not going to accept their work without doing it on my own gun. So that's what I would do, come back and check out the results. But we had a good relationship.

With General Motors Defense Research Lab, all the people there, we went to many conferences together. It was just good friendship and respect for each other's work. I also worked with the Canadians many times. I went to Canada. I worked with the Smithsonian National Physical Observatory and very good relationships with Dr. Whipple. But later on, some of the guys got—well, we were pushing them too hard to give us something. I mean, they were a longtime research doing their thing, and we wanted something specific, so we had to push, and some of them were not too happy about that. But we got the results we needed.

Grumman was good. A similar sort of thing. We'd visit them to see what they had to show us, or McDonnell Douglas, or they would come and talk to us. Workdays were like that. We'd have periodic conferences, either there or back at JSC. In between times, you'd find time to do your own work.

ROSS-NAZZAL: Give us a sense of how difficult or easy it might have been for your branch to deal with the fact that you had weight limitations, but you also had to protect the command module at the same time.

COUR-PALAIS: That's an interesting question. The people in charge of the whole project, of course, were the engineering people. They had the job to do. We were there more or less as not quite interlopers, but what we did was to look at the total [weight] budget, whatever part of their design we could use and incorporate. We would then incorporate that as part of the meteoroid protection. The thing that helped us a lot, too, was they had to protect against radiation, and some of the stuff they put in for radiation protection would also be of use to us. So it was a question of, in some sense, piggybacking.

There were a couple of times when we went out on a limb. One I mentioned already, when we had to go before Wernher von Braun for Skylab.

The second time was when I tried to convince Dr. Max [Maxime A.] Faget that we needed an extra shield over the windows in the command module, and he wasn't buying that. But from our calculations, the windows, even with the smallest pit on them, with the thermal stresses on reentry, could crack, and if you had a confluence of cracks on them, then a piece would drop out. So I wanted to put another sheet of glass on the outside. But this would so modify what they call the mold line, having delicately machined the outside of the spacecraft to make it smooth, there would come this bump. He said, "No way." He said, "I bet you," the way Max Faget would talk, "I could put a piece of cardboard over there and it wouldn't get burnt." [Laughs] He had the last word, so we didn't do that. But that was the kind of thing that a couple of times you'd run up against the engineering, who were in charge.

I think the other thing that we did which did make a difference to engineering was what I mentioned about the LM windows. They would definitely break into popcorn-size pieces of glass. And they listened to us and they put a different kind of glass in the end, which didn't break up.

Talking about glass again, all the Shuttle windows have to be inspected for a pit, and, unfortunately, the size of that pit was based on some of the work that I did, but followed up by later work done by Engineering Division after I left. There's a certain size of pit that could occur on the glass window that, again, even with the Shuttle reentry, would cause that to crack. So they examine the windows—and I think to this day they do—if they come to this certain size of pit, they scrap the windows, and thus they're very expensive. At the time I left, it was $25,000 a pane, one pane. Here again, it was one of those things, you go out on a limb and you're trying to convince other people that this is so with your tests, and that one, they believed that one.

ROSS-NAZZAL: You mentioned that you did some work with the spacesuits themselves.

COUR-PALAIS: Yes.

ROSS-NAZZAL: Did you have any contact with the flight crew members?

COUR-PALAIS: No, I was never party to any of that. The person I came closest to meeting on any of these things would be John [W.] Young, maybe, because he was one of the pioneering astronauts. Even in our presentations before Dr. Gilruth or something like that, I don't remember anybody from the astronauts being there asking us any questions. I don't think anybody ever questioned us on that.

ROSS-NAZZAL: What are your memories of Apollo 11 when it finally landed? Where were you?

COUR-PALAIS: I was on a retreat. I belonged to a group at that time that was doing a sensitivity training. This Roman Catholic group wanted us to come and, for some reason or another, talk to a bunch of Roman Catholic nuns. I was at a place in Humble, Texas, where they and us were watching this landing. So I was watching this landing in connection with a bunch of Roman Catholic nuns. [Laughs] Everybody was being excited, like the whole world was excited. They were excited. Our whole idea was—I don't know what that group was doing at the time. I'm not very happy about it. I was trying to get these people some way or the other more sensitive than they were, but they already are sensitive. I don't know what the reason was, but I was just part of a gang. But that's where I was. Apollo 11.

We went through Apollo 17. I was trying to get data all the way through to that.

To go back to what was the day like. After we shifted into Apollo—and it was definitely a race against the Russians, so everything we did was with that mindset. I mean, people didn't mind working overtime, doing whatever they had to do. Everybody that I know of worked at full bore. We had a lot of stuff that we didn't want them to get to know, so here again, there was a necessity to have some classified information kept locked up. The biggest problem was making sure that the file cabinets were properly locked and secure and all that kind of stuff. Many times you'd run into trouble with that kind of forgetfulness, maybe. So the atmosphere at the time was definitely they were the bad guys, we were the good guys, and we're going to get there first. But in addition to that, there was a lot of excitement and fun work with that. I've enjoyed it.

ROSS-NAZZAL: Can you tell us about going to the Apollo 13 launch? You mentioned that you were there.

COUR-PALAIS: Well, it seemed like every now and then they'd give somebody an opportunity to go to a launch and I'd never had one, so we went there. We were a long way from the launch. I remember standing there by my wife. Did you come too?

ROWLAND COUR-PALAIS: I think I was in college.

COUR-PALAIS: We were standing with the group where the spectators were kept. It was a daylight launch, and when they started up the engines, the rumble would just shake the cavities of your chest, and all the birds would start flying. It really was a spectacular audible; there's no doubt about that. And, of course, the visuals, hoping that it would get up and get going. It just was a wonderful experience. I enjoyed that.

We had driven to Florida. We didn't fly, so it took us a couple of days to come back home, and we didn't know what had happened to Apollo 13 until after I'd got back home. That was a shocker, but my first feeling was, "Gee, I hope it's not a meteorite problem." But when we did the numbers, it was not. We're supposed to ensure the safety of the spacecraft and that wouldn't have done me any good at all.

ROWLAND COUR-PALAIS: Another thing with Apollo 13 was we went to the same church with Jim [James A.] Lovell, so that was kind of interesting time.

COUR-PALAIS: Oh, yes. Jim Lovell.

ROSS-NAZZAL: Were there any special meetings or prayer meetings at the church, for instance? Do you recall any of those incidents?

COUR-PALAIS: I don't recall anything special like that, but I do know that our minister was constantly with Jim Lovell's wife. He was there with her and, of course, we would be asking him things like that, but I don't think we did anything special from that point of view. But individually, yes; I guess the whole world was doing it at the time.

But for my one and only trip to a launch, that was terrible. I don't recall if I've ever gotten to any Shuttle launches. I don't think so. No. That particular phase of my life, as I said earlier, was very different, working with environmental effects. It just didn't have the same feel for me as what my real love was. So when orbital debris came back and I had the option to get back into it, and had a fairly good long-term work in that area again, it was just great to get back into that work, and working with Jeanne was a great pleasure.

ROSS-NAZZAL: I think we should stop here for a second, because we need to change the tape. But I only have only maybe one or two [questions] left. Then I was going to ask Rebecca and Sandra if they had any questions, if that's okay with you. I don't know how tired you're getting.

[Tape change]

ROSS-NAZZAL: You're the first person we've talked to about orbital debris and meteoroids.

COUR-PALAIS: And that Avro Arrow there [gestures], that was what I went to Canada to do. That was a very advanced plane, and I think if everything had been all right, I may have been a Canadian by now instead of an American; I don't know. [Laughs] But there was a whole bunch of us that came down that used to be called Canadians. Not all really Canadians.

ROSS-NAZZAL: Were you grouped together, like the Germans were grouped together?

COUR-PALAIS: Yes, they did that for a while. Most of us went and got our naturalization at the same time. For some reason it took me six years rather than five. I can't understand why, but we got through that. No, I haven't regretted the decision I made when I left Canada, the option of going back to England or coming on Space [Task Group], because this has been a real exciting time. It's always been on the forward edge of something.

I think Space Station—I liked the original one, the Space Station Freedom. It was pretty well advanced at the time, and I think McDonnell Douglas was doing a good job. It's very interesting to me—you might like as a sideline—I became a contractor when I worked with McDonnell Douglas. I could see the other side of the story, how NASA puts the pressure on the contractors. I had to write a report, you know, the constant reporting in and all that kind of stuff, and making sure that we got good marks and all that kind of stuff. Many a time I thought, well, this is interesting. The things that I took for granted when I was with NASA for thirty years, the way the contractors have to respond to NASA are sometimes a pretty bad relationship, but not always. So we did pretty well. I did enjoy seeing it from the other side. Are you all contractors?

ROSS-NAZZAL: Yes, we are.

COUR-PALAIS: Do you have reports to do?

ROSS-NAZZAL: She [Rebecca Wright] does. We don't. We let her work on this.

ROWLAND COUR-PALAIS: This is the one I was thinking about. There's a couple targets in there, but I don't think—

COUR-PALAIS: It's a model of that thing over there, that picture in *National Geographic.* It shows how the ceramic cloth—that's the unique part of that thing. It's a cloth bumper rather than a metallic bumper. It makes a big difference.

You have more questions?

ROSS-NAZZAL: Yes, but I'm interested in hearing—your son wanted to add a quick—

ROWLAND COUR-PALAIS: Well, just a funny little side story. When he did his convention talk down in Galveston, my kids went along to see the display and all that kind of stuff. They were all kind of laughing when they saw the actual invention as it was set up there. They were kind of like, "Well, Granddad, we could have done this in the garage ourselves." It looked like a few pieces of metal in a row there. Then they grew to understand that the invention happened to be the math that went behind how thick each piece had to be and how far apart everything had to be. They really didn't catch on until the *National Geographic* thing, then all of a sudden they realized that he was okay.

ROSS-NAZZAL: Took a lot of work, yes, I'm sure.

ROWLAND COUR-PALAIS: So now they argue about who got his brains. [Laughs]

COUR-PALAIS: Well, I was just fortunate that I was in on the beginning of it all and learned from ground zero, because nobody was offering courses in this stuff at the time.

ROSS-NAZZAL: Let me ask you about the Space Shuttle. Did the meteoroid field or orbital debris field change as a result of using this reusable spacecraft?

COUR-PALAIS: Yes, I think the question of having to examine the tiles every time, to repair them, and I've already mentioned the windows. Orbital debris is so much more prolific than meteoroids in impact. From what I gather, they find impacts fairly regularly on the windows, and if they reach a certain depth, it's a significant decision for somebody to make, at that price, to change out a window. On the tiles, they just go back and repair them, I think; from what I gather, they do.

Then there have been experiments run from Shuttle. They launched—what's the famous orbital debris spacecraft they launched a few years ago? Then they brought it back in. I've forgotten what it was called now, but they put out a canister which had different detectors all the way around it, and then they brought it back and people have gotten a lot of stuff out of that. They also brought back one of the weather satellites which we looked at for impacts.

The Shuttle has been very influential in point of view of the fact that it can bring things back. We can put stuff out there in space and see how it reacts to the orbital debris and meteoroid environments and then get them back and examine them, which was a big thing.

ROSS-NAZZAL: You mentioned that the Shuttle has been very beneficial for allowing you to take up a satellite and bring it back down. How did that impact or change the field of study that you'd been working with since 1960?

COUR-PALAIS: I think from the point of view of what I call tweaking, you get a lot more impacts because you have it out there a long time and you get to see different kinds of impacts. The question then comes up, you have to use a scanning-electron microscope levels to see how many of these are meteoroids and how many are orbital debris. Many papers are written on the composition of what they think that the orbital debris is. Most often, it's aluminum, but quite often there are other materials involved. It's to the point now where it's not affecting the design flux, the design part of it, but it's affecting the details. It's like bringing home a lunar rock and examining it and coming up with some knowledge of what the original particle was like, and then they trace it back to a comet or something like that. From that point of view, collecting debris allows them to look at what they think the Earth was like earlier on.

ROSS-NAZZAL: I just had a couple more questions about orbital debris. I was reading that initially some federal agencies were apprehensive that there was any sort of orbital debris, or that they should be concerned about orbital debris. What are your memories of that?

COUR-PALAIS: Very much. [Laughs] As I told you, this fellow who worked with me, Don Kessler—he's very well known now—he was bringing up this orbital debris thing and the higher-ups did not want to know about it at all, because he was raising a problem and they didn't want any more problems. I remember being told—I wasn't his boss at the time, but they were telling me, "Tell him to come up with solutions rather than problems." They did not want to know about it at the time.

What we eventually had to do was to—I think Ariane, one of the French spacecraft, exploded and we did some papers on that, and also found out that the Delta rockets that they were sending up there to put satellites in space, they would leave them in orbit and they would explode. Eventually, we got to prove to them that they were sources of this stuff, and that all the measurements that were coming in from NORAD [North American Aerospace Defense Command, Colorado Springs, Colorado] and everywhere else, where they could trace these things, it became a proven fact that they couldn't really dodge around; it was true that orbital debris is a menace.

Several countries, including our own country, have tried to prevent further explosions in space. I mean, the Russians were definitely exploding things in space as a defensive measure. They would have these anti-satellite satellites that would go up there and be blown up to destroy something else. Then we had our own inadvertent explosions from these second-stages, Delta rockets or something like that, which they didn't purge the oxygen-hydrogen tanks at the time, and in time, they would build up pressure and blow up. Now they all have to be leaked out. I don't know if the Japanese are following that or not, or whether the Chinese are following that way or not, but, see, the sources are still there. That's where it comes from, other spacecraft, not from anywhere else. And he was right; Don was right. He's since had a lot of awards and things because of that. But at the time, they really regarded him as a menace, it's true. [Laughs]

ROSS-NAZZAL: I understand that you did some briefings with other agencies, with the State Department and the Department of Transportation, about orbital debris.

COUR-PALAIS: Not me. No, not I. We did go to [NASA] Headquarters [Washington, D.C.] and we did go to a couple of Defense locations. We went to [Y-12 National Security Complex in] Oak Ridge [Tennessee] to tell them about this stuff. That was an interesting environment there. They didn't seem to want to know about it either. But we had a lot of things like that.

Classified work is hard to do, very hard to do, so it's better not to be working in that field. So when they declassified that shield, it became much easier to do other things.

ROSS-NAZZAL: Let me ask Rebecca or Sandra if they have any questions for you.

WRIGHT: I have a couple. I was just going to ask you a question about the work you were doing with the Shuttle Program. You said that you worked with people from Marshall Space Flight Center and from Kennedy. Could you share with us how those three Centers' representatives worked together on those specific topics that you were looking at?

COUR-PALAIS: It was basically Langley. Langley, Marshall, and ourselves, and, yes, KSC, too. I think we worked pretty well. Let's see. I think it was Langley that provided the aircraft that would fly through the plumes. So they were in a field in which we sort of—we owed them that. They had the means of detection and they could tell us what they found. Marshall was into what we called modeling the plume. They had a couple of people over there who were expert in that field. Our job, from the Manned Spacecraft Center point of view, was to ensure that we were funding the right things to look at. Then KSC would tell us about the bees and the orange groves and other things that could be harmed, manatees and stuff like that.

So I guess it was a collaborative effect, because each one was doing their own thing. There was no competition in that sense, except that occasionally we would question the results, because if you're going to spend money on it, you do that kind of stuff.

The Tropospheric Project, mine was primarily, management of resources and things like that, and making sure that JSC's concerns would meet with—see, our own engineering group over here didn't want to be stopped by any of these things, so we were caught in the middle. But it was a very collaborative event.

WRIGHT: Did it last for an extended period of time?

COUR-PALAIS: The sense of time has disappeared, but you put a time frame on this and it's interesting to me that I was there three years. It says here '74 to '78. Four years in that group. It lasted four years.

WRIGHT: When you and your group moved from Ellington to Building 31, and you said the building was specially designed so you could use the gun. Did you have input on how that building needed to be designed?

COUR-PALAIS: Yes.

WRIGHT: Could you share more about how that building was designed for your work?

COUR-PALAIS: The building was just a normal office building, but on the lab side, we had the experience from General Motors Defense Research Lab. They were firing some toxic stuff. If you fired cadmium or anything like that, it gives off a very poisonous gas, so you had to have these huge extractor fans. We didn't know whether we were going to do anything toxic or not, but based on what we saw at General Motors in Santa Barbara, we decided we'd better have huge fans in the ceiling to exhaust any toxic gases we might have.

We knew that there was an explosive risk on the gun and, therefore, nobody could be in that room when it was fired, so we had to have the control panels outside a concrete wall. So it was designed so that the gun would be remotely fired, everybody out of the way. The third thing they did was to ensure that if there was a massive explosion, that the roof would have some venting. So it was tailored in that sense to be a gun lab.

I don't know if you know 31; it's at the far end of 31. It sort of lies across the back there. I don't know what they've done with it now. So we did have those kind of inputs, mainly based on what we'd seen on the West Coast. They'd had the experience.

WRIGHT: My last question is, could you tell us how you chose the peninsula of Canyon Lake to first do your observation?

COUR-PALAIS: Well, we needed clear skies and we couldn't find anything in Houston. At that time, I thought to myself, "Well, it should be pretty dry and nice out there in Southwest Texas, wherever we are." But we didn't get too many bad nights, but we had some few bad nights.

But the peninsula over there [gestures] was the [U.S. Army] Corps of Engineers, they were, I guess, working with the dam, and we could stow our equipment over there. It was just nothing like now. There were no houses. It was pitch black, and just ideal to sit on the hillside up there. We all had these recliners, deck chairs, and the recording van. So several of the people—two of those who just drove away from [the house]. They were students at [Texas State University] San Marcos [San Marcos, Texas] at the time—they would come out and help us spend the night looking for meteors.

The machine was what was doing the tracking. It was taking a spectrograph of the incoming projectile or meteor, so we could analyze what it was made of.

WRIGHT: How big was your group that would come out to observe?

COUR-PALAIS: There was the lab technician, who drove the van with the thing on it. There was myself and one other guy. The three of us, and anybody who wanted to join in, like those two guys.

WRIGHT: So you would just spend the night, one night?

COUR-PALAIS: No, several nights.

WRIGHT: And how often did you come out to do that?

COUR-PALAIS: Oh, maybe two or three times a year. You've probably heard of the meteor showers that we get. That was the best time to come, when there was a predicted shower, because then we'd have a chance of seeing more meteors. So we would come during that time. There still is over there, a motel on that side of the lake where we could spend—it was very cheap at that time. You could cook your own food and all that kind of stuff. There was one little grocery store where you could buy steaks and things like that. So we could spend several nights there. But it was a disappointment in the fact that it wasn't always clear skies. You really had to go further west. But that's when I got to know Canyon Lake.

WRIGHT: And you chose to come back here to live.

COUR-PALAIS: Yes. After I joined McDonnell Douglas—apparently it happens to somebody who's retired after a long time—I got a bad case of shingles. Anyway, I was recuperating here with some friends and we just decided that this was better than—it just seemed like it was right. The lake is pretty. I don't do any fishing. I don't do boating. I do nothing except sit and look at it. [Laughter]

WRIGHT: Sounds like a good pastime to me.

ROSS-NAZZAL: Do you think there's anything else we need to cover that we haven't gone over today, that we may have overlooked?

COUR-PALAIS: Did you get these dates and things from my bio?

ROSS-NAZZAL: Yes.

COUR-PALAIS: And they don't mention that I was Branch Chief there? Because that, to me, is an important part of my life over there. I'd like to see that included.

ROSS-NAZZAL: Yes, and that will be. We'll send you a copy of the bio sheet that's going online and that's going to be archived.

COUR-PALAIS: The other thing that was significant was the fact of being the Subsystem Manager for Meteoroid Protection for Apollo. They have subsystem managers for all kinds of things, and it was one that definitely caused me to have to really keep on my toes, because I was responsible to them. It was not just fooling-around research. That, too, is a significant title that I had in there.

Otherwise, I can't think of anything else at the moment. Settling down in Texas was difficult at the beginning. I thought we were all going to go to [Goddard Space Flight Center, Greenbelt] Maryland from Space Task Group originally, but we got down here and it took us several years to get acclimatized, but I think we enjoyed it; still do.

ROSS-NAZZAL: We very much enjoyed hearing your stories today.

COUR-PALAIS: Thank you. Thank you very much for coming out.

ROSS-NAZZAL: Thank you.

[End of interview]